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RADIATION INDUCED VARIABILITY IN CROSSANDRA (*CROSSANDRA INFUNDIBULIFORMIS* (L.) NEES)

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ABSTRACT

An investigation on the induction of mutation in crossandra was carried out with the objective of creating genetic variability through physical mutagen *viz.*, gamma rays (10, 20, 30, 40 and 50 kR) on seed germination, seedling survival, growth and floral characters. Seeds of local orange type of crossandra were subjected to treatments at different doses. The percentage of germination and survival was affected significantly at higher doses. The LD_{50} value for gamma rays for seed germination and seedling survival was ranged from 20 to 30 kR. Reduction in germination, survival percentage, plant height, internodal length, no. of leaves, length of leaf, breadth of leaf, no. of branches and length of branches and floral characteristics were observed upon irradiation and with increase in dose of gamma rays. Days for first flowering were significantly delayed upon exposure to increase in dose of gamma rays. No. of spikes per plant, no. of flowers per spike, length of spike, length of corolla tube, no. of flowers per plant and yield per plant were increased at lower radiation dose of 10 and 20 kR than control. Leaf abnormalities were also observed at higher doses. Stimulating effect of gamma radiation was observed at 10 and 20 kR where almost all the characters showed positive shift including growth and yield attributes.

KEYWORDS: Crossandra, Gamma Rays, Mutation

INTRODUCTION

Crossandra infundibuliformis (L.) Nees is commonly called as Fire Cracker flower belonging to Acanthaceae family is native to Asia, South America, South Africa and Madagascar. Crossandra is an important traditional flower crop of south India which produces beautiful flowers in dense sessile spikes with a remarkable range of colours almost all the year. The genus consists of 20-25 species and commercially cultivated species is *Crossandra infundibuliformis.* It is cultivated commercially mainly for loose flower purpose. The orange type is the only variety commercially grown. Variability available in crossandra is very low. Velusamy *et al.* (1974) have also stressed the need for evolving new forms with many shades of colour, attractive shape and size of flower, heavy yield, better keeping quality and resistance to pests and diseases. Thus, mutation breeding has shown promise in creating wide variability for morphological characters including plant height, number of flowers per plant and flower colour. The application of mutagenesis has vast potential for increasing the available genetic variation. By 2003 more than 2252 improved varieties have been developed in different flower crops through mutation breeding and in Asia 50 per cent of the released varieties are through mutation breeding. In India, so far 259 varieties are developed through induced mutagenesis. Among all the varieties developed through mutation

breeding in India, 18 per cent of them were developed by altering plant type (Jain, 2010). Approximately 30 % of the chrysanthemum cultivars have also originated in India as mutants for which wide range of chemical and physical mutagens have been used. Information on the differential sensitivity of the genotype to different mutagenic treatments is not available for most of the commercial flower crops and in particular of crossandra. Hence, the present investigation was carried out to examine the effects of gamma rays on seed germination, seedling survival, growth and floral characters.

MATERIALS AND METHODS

The experiment was conducted at Horticultural College and Research Institute, Periyakulam during 2013-14 to evaluate the effect of different dose of gamma rays on germination, survival and growth performance of crossandra. The experiment was laid out in randomized block design. The radiation doses *viz.*, 10, 20, 30, 40, 50 kR and Control (Dry) – Untreated seeds. The local crossandra type was subjected to mutagenic treatments. Only seeds with white cotyledons were selected and used for mutagenic treatments, as seeds with brownish cotyledon do not germinate well. The physical mutagen namely gamma rays (ionizing radiation) was employed for the study. Irradiation with gamma rays was given from the Gamma chamber installed at Tamil Nadu Agricultural University, Coimbatore by the Bhaba Atomic Research Centre, Trombay.

Seeds with a moisture content of 9± 1 per cent were chosen for irradiation. Samples of 200 seeds per treatment were packed in butter paper covers and placed in the 1000 curie ^{60}Co gamma chamber. The treatments were given for various durations depending on the doses required with the dose rate of 11.14 rads /sec. After imposing treatments, seeds were sown in protrays containing sterilized cocopeat. Lethal Dose was determined by measuring the seed germination, seedling height, survival percentage and emergence of the M_1 generation under field conditions. When the seedlings attained four leaf stages, they were transplanted in the main field. Data's were recorded on germination, survival and growth characters in the M_1 generation. The data of the field observations were analyzed using 'F' test for significance following the methods described by Panse and Sukhatme (1964). The values recorded in percentage were transformed in to angular values prior to analysis wherever necessary.

RESULTS AND DISCUSSIONS

The per cent germination and survival decreased with the increase in the dose of gamma rays. The reduction in the germination and survival was specific in the higher dose of gamma rays. The seeds treated with 10 and 20 kR exbhited 63.69 and 59.64 respectively than control (51.36) whereas at 50 kR recorded (26.31) lower germination per cent. There was a progressive reduction in seedling survival with increase in the doses. The lowest per cent of survival of 16.97 was observed at 50 kR while the highest was 61.09 at 10 kR as compared to 48.06 per cent in control (Table 1). The LD_{50} for germination and survival was between 20 and 30 kR. Similar result were obtained by Banerji and Datta (1992, 2002) who observed reduction in survival percentage with increasing dose of gamma irradiation in chrysanthemum cv. 'Jaya and Lalima'. Possibly the reduction in germination and survival per cent due to gamma rays may be attributed to drop in the auxin level (Gordon and Webber, 1955) or chromosomal aberrations as reported by Reed (1959) and Sparrow (1961).

All the growth characters were increased significantly at 10 and 20 kR gamma rays whereas the higher dose of 50 kR has decreased all the growth characters than control. The increased dose of gamma rays reduced the plant height, internodal length, no. of leaves, length of leaf, breadth of leaf, no. of branches and length of branches from 72.90 cm, 3.39 cm, 153.69, 9.13 cm, 4.07 cm, 13.42 and 24.08 in control to 38.62 cm, 2.17 cm, 125.47, 5.95 cm, 3.07 cm, 10.04 and 12.06

cm at 50 kR respectively. However, the seeds treated with 20 kR has recorded the higher plant height, internodal length, no. of leaves, length of leaf, breadth of leaf, no. of branches and length of branches *viz.*, 81.56 cm, 3.56 cm, 190.19, 10.39 cm, 4.67 cm, 25.48, 27.65 cm respectively than control (Table 2). Similar results were found by Dhaduk (1992) in cv. Melody at 1kR. The lower levels of mutagens are themselves not responsible for stimulating sprouting but the substances such as enzymes that are set free by irradiation and low doses causes stimulations as the enzymes play pivotal role in plant metabolism (Cantor *et al.*, 2002). Higher radiation doses might have harmful effects on auxins and other growth substances influencing the chromosomes and the plant tissue. Singh *et al*. (2009) also reported reduction of plant height with increasing dose of gamma rays at 200 Grays.

Table 1: Germination and Survival Percentage in M_1 Generation

Treatments	Germination Per cent	Per Cent of Control	Survival Percentage	Per Cent of Control
Control (dry)	51.36	100.00	48.06	100.00
10 kR	63.69	124.00	61.09	127.11
20 kR	59.64	116.12	57.04	118.68
30 kR	44.64	86.91	37.74	78.52
40 kR	29.46	57.35	18.41	38.30
50 kR	26.31	51.22	16.97	35.31
Mean	**45.85**	**89.27**	**39.88**	**82.97**
SEd	0.91	-	0.77	-
CD (P= 0.05)	2.03**	-	1.72 **	-

Table 2: Effect of Gamma Rays on Growth Parameters of Crossandra in M_1 Generation

Treatments	PH	IL	NL	LL	BL	NB	LB
Control (dry)	72.90	3.39	153.69	9.13	4.07	13.42	24.08
10 kR	78.60	3.27	170.56	9.67	4.23	22.52	24.55
20 kR	81.56	3.56	190.19	10.39	4.67	25.48	27.65
30 kR	47.31	2.79	150.90	7.43	4.07	18.27	17.48
40 kR	41.43	2.21	137.13	6.47	3.25	12.48	13.03
50 kR	38.62	2.17	125.47	5.95	3.07	10.04	12.06
Mean	**60.07**	**2.89**	**154.65**	**8.17**	**3.89**	**17.03**	**19.80**
SEd	1.12	0.05	2.78	0.14	0.70	0.31	0.36
CD (P = 0.05)	2.49**	0.11**	6.21**	0.33**	0.15**	0.70**	0.82**

PH – Plant height (cm), IL – Internodal length (cm), NL- No. of Leaves, LL- Length of the leaf (cm), BL – Breadth of leaf (cm), NB- No. of Branches, LB- Length of branches (cm), DFF- Days for first flowering, NSP- No. of spikes per plant, NFS – No. of flowers per spike, LS- Length of spike (cm), LCT- Length of corolla tube (cm), DF – Diameter of flower (cm), NFP- No. of flowers per plant, YPP- Yield per plant (g).

Observation on floral characteristics was recorded on control to 50 kR gamma rays are presented in the Table 3. The gamma radiation dose at 10 kR took only 71.79 days for first flowering than control (84. 49 days) whereas at higher concentrations has took maximum no. of days for first flowering. Flowering was delayed significantly at 50 kR. The radiations reduced the no. of spikes per plant, no. of flowers per spike, length of spike, length of corolla tube, no. of flowers per plant and yield per plant affected adversely at higher radiation dose i.e. 50 kR. It may be due to auxin destruction, irregular auxin synthesis, failure of assimilation, mechanisms or inhibition of mitotic and chromosomal changes or damage with association of secondary physiological damage, which support the findings (Banerji *et al.*, 1996). The radiation dose at 20 kR has recorded maximum, no. of spikes per plant, no. of flowers per spike, no. of flowers per plant and yield per plant of 61.24, 36.19, 1667.26 and 82.31 g respectively whereas the dose at 10 kR has recorded the

maximum length of spike, length of corolla tube, diameter of flower of 10.11 cm, 2.55 cm and 2.52 cm respectively than control. No. of flowers present in a spike determine the total yield per plant. Tonakanjan (1968) reported increased number of flowers in candytuft at 125-1000 rad of x-ray treatments. Nikolova and Vasileva (1979) also reported increased number of flowers in *Zinnia elegans* by treating the seeds with gamma rays.

Table 3: Effect of Gamma Rays on Floral Characteristics of Crossandra in M_1 Generation

Treatment	DFF	NSP	NFS	LS	LCT	DF	NFP	YPP
Control (dry)	84.49	33.69	23.06	5.60	2.18	2.34	1505.01	52.49
10 kR	71.79	52.41	35.41	10.11	2.55	2.52	1600.51	71.32
20 kR	72.84	61.24	36.19	8.40	2.43	2.49	1667.26	82.31
30 kR	106.29	47.24	24.56	6.88	2.15	3.06	1343.01	48.56
40 kR	113.09	30.21	21.06	5.35	1.95	2.51	1148.76	39.66
50 kR	116.24	28.13	20.80	5.22	1.32	2.35	1151.33	35.13
Mean	**94.12**	**42.15**	**26.84**	**6.92**	**2.09**	**2.54**	**1402.64**	**54.91**
SEd	1.71	0.49	0.49	0.12	0.03	0.04	25.33	1.02
CD (P = 0.05)	3.82**	1.09**	1.09**	0.28	0.08**	0.10**	56.45**	2.27**

PH – Plant height (cm), IL – Internodal length (cm), NL- No. of Leaves, LL- Length of the leaf (cm), BL – Breadth of leaf (cm), NB- No. of Branches, LB- Length of branches (cm), DFF- Days for first flowering, NSP- No. of spikes per plant, NFS – No. of flowers per spike, LS- Length of spike (cm), LCT- Length of corolla tube (cm), DF – Diameter of flower (cm), NFP- No. of flowers per plant, YPP- Yield per plant (g).

CONCLUSIONS

It is concluded that lower radiation dose of gamma rays resulted in higher germination and survival percentage. It is mainly depended upon the nature and extent of chromosome damage. Increase in plant height, other growth parameters and increased flower production at lower doses was due to the stimulating effect of gamma rays. On the whole, the study revealed that the exposure of seeds at 10 and 20 kR is best for improving growth and yield in the crossandra. Although, there is a need to carry out further generations and to initiate extensive research work using large number of mutagens alone or in combination to induce really desirable variability under *in vitro* and *in vivo* in order to obtain novel and economic mutants in crossandra.

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